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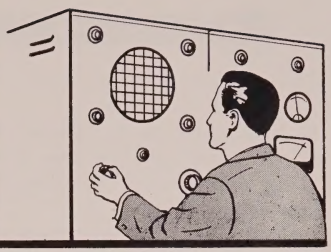

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Aids To Timing - Circuit Design

Part 2 RL Circuits

In the resistance-inductance (RL) timing circuit, current increases (on make) or decreases (on break) through R and L in series. Sometimes the inductor is the coil of a relay timed by the process. The current is $I = (E/R)\,e$ (where I is the instantaneous current in amperes, E the steady-state d-c supply voltage, t the time interval in seconds from the instant of closing or opening the circuit, R the resistance in ohms, L the inductance in henrys, and e the base of natural logarithms = 2.71828). The time constant of the circuit is given as $t = L/R$ (where t is the time in seconds required for the current to build up (after make) to 0.6321 maximum or to decay (after break) to 0.3679 maximum, R the resistance in ohms, and L the inductance in henrys).

As mentioned in Part 1 regarding the RC timing circuit, the calculations for determining required values for LR circuits are simple ($t = L/R$, $R = L/t$, $L = tR$), but they can become time-consuming when a number of them must be made. The charts presented in this article will lighten this task. Figure 1 is a graph for determining t or R when $L = 1$ henry. For other values of inductance when t is known, multiply the indicated resistance by L, where L is the desired inductance in henrys. For desired values of t and/or R other than those shown on the graph, shift the decimal point, as required, by the same amount and in the same direction on resistance and time scales.

For more accurate results, use Tables 1 and 2, which give resistance values required with thirteen common inductances (10 millihenrys to 100 henrys) and for thirty-eight time rates (1 millisecond to 10 seconds for both charts). Resistance values are not carried lower than 5 ohms, since below that figure stray circuit resistance might possibly compete with the timing resistance. Timing rates are not carried lower than 1 msec nor higher than 10 sec, since this range seems most called

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for in LR timing practice. However, R, L, and t values other than those given in the tables may be determined by means of interpolation.

The circuit designer must remember that inductors of all kinds have a certain amount of internal resistance unavoidably resulting from the resistance of the wire with which they are wound. This varies, of course, with type, manufacture, and inductance of the inductor, but usually is low only in those units which are large in size for a given inductance rating.

This inherent resistance acts in series with the inductance and must be taken into account when determining required resistance for an RL timing circuit.

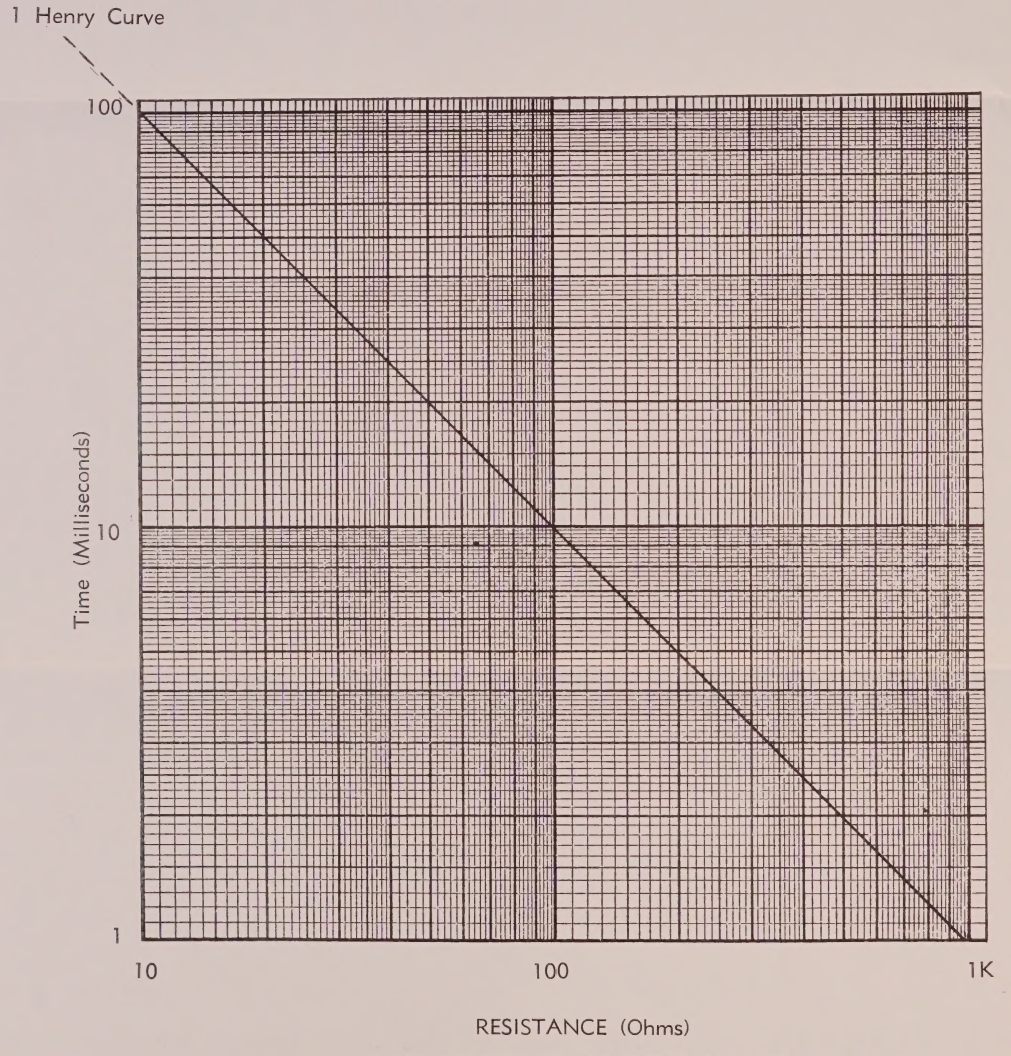

FIGURE 1. RL CIRCUIT CURVE

TIME (t in millisec-onds)	INDUCTANCE (L in henrys)												
	0.01	0.02	0.05	0.1	0.2	0.5	1	2	5	10	20	50	100
1	10	20	50	100	200	500	1K	2K	5K	10K	20K	50K	100K
2	5	10	25	50	100	250	500	1K	2.5K	5K	10K	25K	50K
3		6.7	16.7	33	67	167	330	670	1.67K	3.3K	6.7K	16.7K	33K
4		5	12.5	25	50	125	250	500	1.25K	2.5K	5K	12.5K	25K
5			10	20	40	100	200	400	1K	2K	4K	10K	20K
6			8.3	16.7	33.3	83	167	333	830	1.67K	3.33K	8.3K	16.7K
7			7.1	14.3	28.6	71	143	286	710	1.43K	2.86K	7.1K	14.3K
8			6.2	12.5	25	62	125	250	620	1.25K	2.5K	6.2K	12.5K
9			5.5	11.1	22.2	55	110	222	550	1.1K	2.22K	5.5K	11.1K
10				10	20	50	100	200	500	1K	2K	5K	10K
20				5	10	25	50	100	250	500	1K	2.5K	5K
30					6.7	16.7	33.3	67	167	330	670	1.67K	3.3K
40					5	12.5	25	50	125	250	500	1.25K	2.5K
50						10	20	40	100	200	400	1K	2K
60						8.3	16.7	33.3	83	167	330	830	1.67K
70						7.1	14.3	28.6	71	143	286	710	1.43K
80						6.2	12.5	25	62	125	250	620	1.25K
90						5.5	11	22.2	55	110	222	550	1.11K
100						5	10	20	50	100	200	500	1K

K=kilohms

TABLE 1. RESISTANCE VALUES

TIME (t in seconds)	INDUCTANCE (L in henrys)							
	0.5	1	2	5	10	20	50	100
0.1	5	10	20	50	100	200	500	1K
0.2		5	10	25	50	100	250	500
0.3			6.7	16.7	33	67	167	330
0.4			5	12.5	25	50	125	250
0.5				10	20	40	100	200
0.6				8.3	16.7	33	83	167
0.7				7.1	14.3	28.6	71	143
0.8				6.2	12.5	25	62	125
0.9				5.5	11	22.2	55	110
1				5	10	20	50	100
2					5	10	25	50
3						6.7	16.7	33
4						5	12.5	25
5							10	20
6							8.3	16.7
7							7.1	14.3
8							6.2	12.5
9							5.5	11
10							5	10

K=kilohms

TABLE 2. RESISTANCE VALUES

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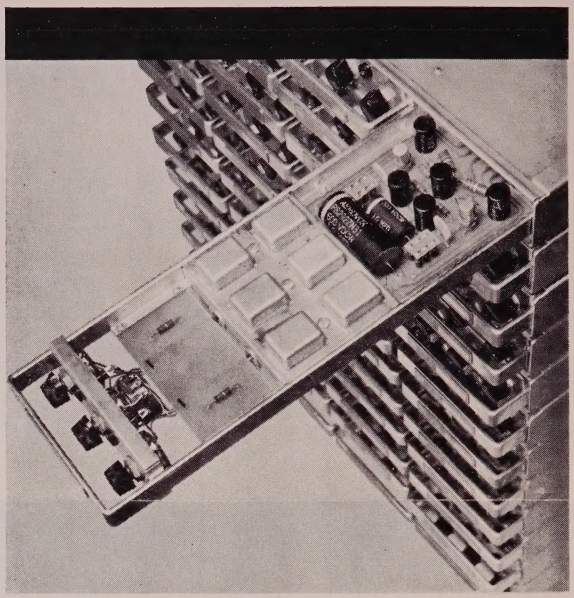

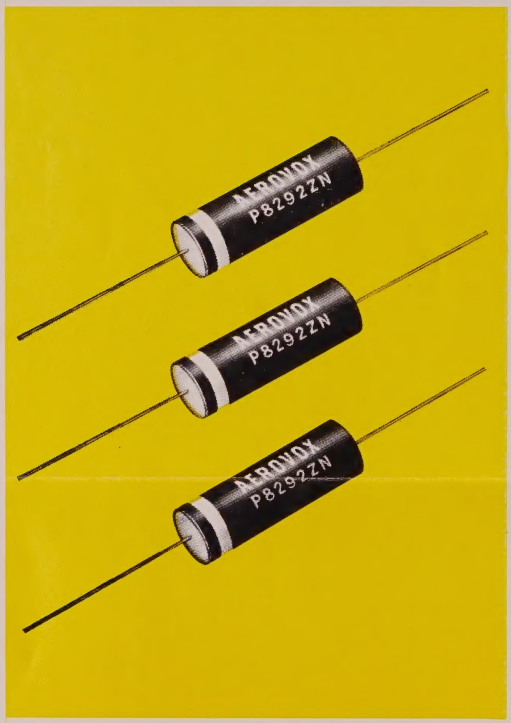

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